It's Not Just About Attention to Details: Redefining the Talents Autistic Software Developers Bring to Software Development

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Abstract

Technology giants SAP, Google and Microsoft have recently begun hiring initiatives targeting individuals with Autism Spectrum Condition (ASC) for software development roles. In order to fully engage and include individuals with ASC, a deeper understanding of the cognitive style and talents of individuals with ASC is needed. In this paper we present an analysis of current cognitive theories of autism, and promote the theory of hyper-systemizing as one that best explains the talents and challenges that surface in ASC. We compare the talents of individuals with ASC to skills required of software developers and identify synergies between the developer skills and strengths of individuals with ASC, such as systemizing, information processing, and specialization of interests. Our analysis concludes with a synthesis of the strategies necessary to create inclusive workplaces that promote the professional development of individuals with ASC.

1. Introduction

With the rising prevalence of Autism Spectrum Condition (ASC), coupled with the unmet employment demands of the technology industry, there is increased effort to connect high functioning individuals with ASC with jobs in the technology industry [2, 7]. Leaders in this effort are smaller firms like Specialisterne [7], which later informed employment programs of technology giants SAP, Google and Microsoft [2; 19]. These companies stated social responsibility and business benefits as two drivers for their initiatives to hire and onboard individuals with ASC [2, 19, 31].

From a social responsibility perspective, champions of such programs point to the growing number of individuals with ASC and the challenges the population faces in securing meaningful employment [3, 7, 28]. A recent longitudinal study found that only 58% of young adults (21-25) with ASC were employed for pay, compared to 99% of neuro-typical young adults [25]. In fact, the report suggests that overall, individuals with ASC face higher barriers in securing employment or pursuing postsecondary education compared to all other groups of young adults who enrolled in special education services while in high school [28, 25]. Even when employed, individuals with ASC face discrimination and isolation in the workplace [19, 6]. Motivated by these social challenges, a few individuals who have children on the autism spectrum created technology firms (Specialisterne and Aspiritech) that hire and integrate individuals with ASC in technology roles [7, 2].

Following suit, larger technology firms like SAP, Microsoft, and Google initiated similar employment programs as they recognized not only the social impact such programs could make, but also the potential benefits of hiring individuals with ASC [2, 19, 7]. Tech companies and scholars from various fields recognized the leanings of individuals on the spectrum to pursue technical interests [17]. For example, a recent national longitudinal study revealed that individuals with ASC are more likely to pursue and persist in STEM fields in postsecondary education than non-STEM fields [32]. This, along with initial success from companies such as Specialisterne at hiring individuals with ASC, emphasized the potential business benefits of hiring individuals with ASC. Tapping into the unemployed or underemployed ASC population provides an opportunity for technology companies to meet the rising demand for technology workers. Furthermore, technology companies benefit from the unique talents of employees on the autism spectrum, such as attention to detail, high level of focus, comfort with doing repetitive behavior, and ability to visualize problems [2, 19].

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The early programs and studies of employing individuals with ASC in technical roles stressed the importance of the population's unique abilities to focus on detail and comfort with repetitive tasks [2, 19, 17]. In particular, scholars and champions of ASC technical employment programs stressed that developers with ASC possess cognitive skills especially suitable for certain roles in the technology industry [2]. These scholars and practitioners suggest that individuals with high functioning autism (HFA) are especially skilled, even more capable than neuro-typical developers, at paying attention to detail, detecting error, and orderly coding (e.g. [2, 19, 17]). They suggest that these cognitive capabilities make developers with ASC especially suited for software testing, quality control, and security work [2].

While we agree that these talents of attention to detail, high level of focus, and ability to focus on repetitive tasks are possessed by some developers on the autism spectrum and fulfill important roles in the industry; they are not the full extent of the depth of talents that these individuals bring to the technology industry. These surface level talents of individuals with ASC are merely aspects of a higher level cognitive style capable of drawing and detecting patterns and rules in the context of complex systemizing [4]. Rather than focusing solely on the surface level talents of individuals with ASC, an approach that capitalizes on the underlying cognitive styles of ASC will enable individuals with ASC and employers to more holistically apply their talents.

The purpose of this paper is to further develop our understanding of the cognitive capabilities of high functioning individuals on the autism spectrum drawing on theories of psychology and neurology. We present our research that identifies and maps the cognitive style of ASC to skills relevant for software developers to demonstrate a more systematic approach to better utilizing the true unique cognitive style of developers with ASC. Our paper concludes with well-informed strategies to accommodate and foster the strengths of individuals with ASC.

2. Autism Spectrum Condition Talents Explored

There is a rich diversity of cognitive abilities and characteristics within the autism population. According to the 5th edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-V) [1], ASC is a lifelong neurological condition impacting an individual's communication and social abilities, along with restricted behavior, interests, or activities [1]. Sometimes, not always, ASC affects cognitive development [22]. Co-occurring with autism are sensory processing problems, manifesting as sensitivity to sensory stimuli such as sounds and lights [1]. The autism behavioral symptoms are characterized as restricted, repetitive motor movements and restricted interests. An autistic individual may make repetitive motor movements (e.g., body rocking). Restricted interests can manifest as having an intense focus on an interest area, such as trains. This intense focus can impact social interactions and may cause difficulty in establishing diverse relationships [12].

Autism is a spectrum condition encompassing a wide range of severity levels for autism-related symptoms. For instance, along the range of communication, one autistic person can be nonverbal while another autistic person experienced delayed speech. The DSM-V, which is used for medical diagnosis, distinguishes between low functioning autism (LFA) and high functioning autism (HFA) [1]. The DSM-V suggests that high functioning individuals on the spectrum score above-average range on intelligence tests, make up 50% of individuals on the spectrum, and are the fastest growing sector of the ASC population [22].

2.1. Hyper-systemizing Theory of Autism

High functioning individuals with ASC possess unique talents. While there is not a clear agreement on one comprehensive theory to define the cognitive skills of individuals on the spectrum, we draw on a prevailing theory, hyper-systemizing, posited by Simon Baron-Cohen. Baron-Cohen et al [4] suggest that characteristics of autism serve a unique cognitive ability to process a high amount of information in the service of systemizing. We draw on the hyper-systemizing theory as opposed to others, namely the executive function [26] and weak central coherence [10] theories of autism, because it is the only theory that attempts to address the cognitive talents of individuals with ASC, which is the focus of our paper.

As Baron-Cohen et al. [4] suggest, high functioning individuals on the spectrum possess a hyper-systemizing cognitive style. They explain that individuals on the spectrum become experts at systemizing; "recognizing repeating patterns in stimuli" to construct systems; rule-based systems in the form of "if p then q" [4, pg. 1377]. Hyper-systemizing ability is associated with 1) sensory

hypersensitivity and 2) hyper-attention to detail. Baron-Cohen et al. [4] posits that individuals with ASC possess a greater sensory perception and memory. This hyper-sensitivity possibly enables individuals with ASC to perceive and process a much higher quantity of information, leading to hyper-attention to detail, and ultimately, leading to hyper-systemizing. The hyper-systemizing theory differs in that it explains the attention to detail "as highly purposeful: it exists in order to understand a system. Attention to detail is occurring for positive reasons: in the service of achieving an ultimate understanding of a system (however small and specific that system might be)" [4, pg. 1378]. Furthermore, at the neurological level, ASC "involves an abundance of local short-range connectivity" that enables individuals to process a high level of information and connect it to their understanding of the system, one piece at a time. Baron-Cohen [4] suggest that systemizing is a way of predicting outcomes of the system.

The hyper-systemizing theory provides a richer understanding of the true capabilities and limitations of high functioning autistics individuals (refer to Appendix A for a mapping of capabilities and limitations). On the one hand, autistic individuals gain strengths by interpreting the world as a rule-based system, including developing a systems-view of stimuli they receive from the environment [4]. On the other hand, this systemizing requires that a significantly higher timeframe, attention and energy be spent on explaining details, especially when attempting to process a significantly high level of information [4, 19]. Also, the focus on rule based systems makes it difficult for individuals with ASC to adapt to change quickly and, thus, they appear to be rigid [19, 29].

Hyper-attention to details means that individuals with ASC have a great capacity for perceiving and processing information to serve the development of a system view of problems and situations of deep interest [4]. Attention to details however present challenges in regards to time management and narrow interests [11, 19]. Lastly, while sensory hypersensitivity enables individuals on the spectrum to perceive and process larger quantity of information, they often feel anxious and overstimulated [11, 27, 29]. This presents challenges in terms of listening and multi-tasking [19].

The strengths posited by the -systemizing theory and further studies suggest talents beyond attention to details are particularly important for software development, one of many career paths suitable for the talents of HFA individuals. In the next section, we review the need for software developers and the desired skills for software developers.

3. The Context of Software Development

The U.S. economy continues to compete for talented software and application developers [13]. According to the Bureau of Labor Statistics, the number of software developer and programmer positions continue to grow, as shown by the trend line in Figure 1. These positions are "expected to add 279,500 jobs by 2022, accounting for about 4 out of 10 new jobs in the computer and math occupations group" [24]. While programmer jobs are projected to gradually decline by 8% by 2024 [13]; software developer jobs are growing at a rate of 17%; much faster than average compared to other professional jobs [24]. Consistently, companies are challenged in filling software development positions available due to tough global competition for such talent (Bagley 2014).

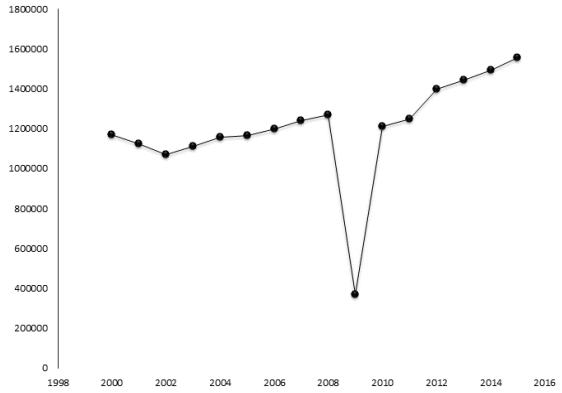

Figure 1. The Number of Software Developers and Programmers in the US (complied from all the years) Source: http://www.bls.gov/oes/tables.htm

Not only is it imperative for tech companies to meet the demand for software talent, they must do so with a diverse pool of developers [2, 8]. To remain relevant, tech organizations must invest in attracting and retaining groups with diverse capabilities, backgrounds, experiences, and skills that lead to greater innovation, better-served consumers, a more skilled workforce, and heightened economic productivity as well as advocating social fairness [9]. Diverse teams consistently outperform even the teams comprising the highest-ability members [18]. Cognitive diversity is especially important in software development [2]. Cognitive diversity leads

to better problem solving and innovation [2], which is especially important for the complex, ever-changing technology industry.

3.1. Identifying Cognitive Skills Requirements for Software Developers

To understand the technology industry's needs for cognitive skills for software developers, we synthesized the skills identified in the current literature and by the U.S. Department of Labor published in the O*NET OnLine repository [20]. Appendix B provides a list and definitions of the skills identified. To confirm the completeness and currency of these skills, we collected and analyzed 20 software development job descriptions from a balanced mix of product and service companies ranging from startups to industry leaders who are engaged in banking, healthcare, ecommerce, consulting and technology products. This exercise was meant to be illustrative rather than comprehensive of the required skills. Our review of the literature and analysis of the job descriptions concluded that the skills required by software developers were broadly categorized as analytical, design, communication, collaboration/relationship and management skills. There is a wide range of skills required across the jobs analyzed. Our analysis revealed that the emphasis was on analytical, teamwork and coordination skills. In terms of analytical skills, programming (90%) and problem solving (60%) were the two most often listed required skills in job descriptions. Design and modeling was listed in 75% of job descriptions and coordination and teamwork were listed in 65% of job descriptions. Figure 2 presents a summary of the skills and their occurrence across the 20 job description.

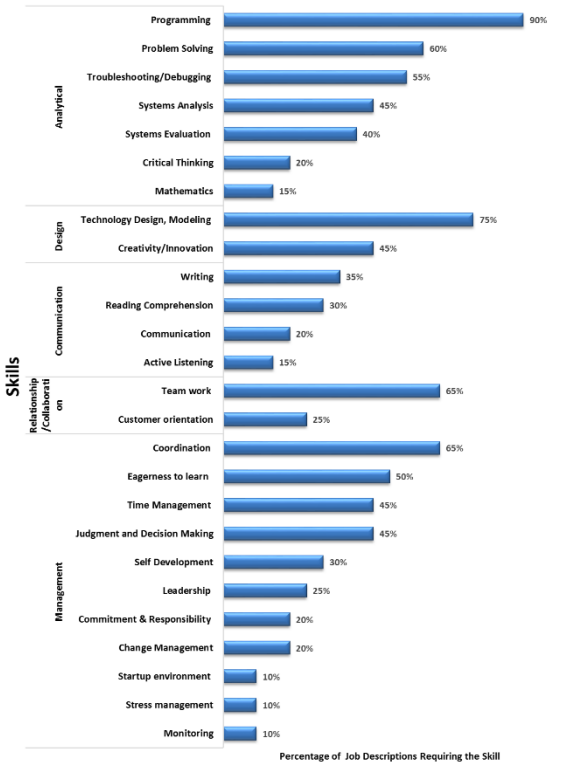

Figure 2. Skills required in 20 representative software development job descriptions.

3.2. Hyper-systemizing Meets the Range of Analytical Skills for Software Development

Programming and problem solving were the two most often required analytical skills required for software development. Programming refers to writing computer programs for various purposes. Problem solving involves identifying complex problems, reviewing relevant information to develop and evaluate options, and implementing solutions [15, 16]. Per the hyper-systemizing theory of autism, high functioning individuals on the spectrum have a unique ability to pay attention to detail in the context of complex systems, which are characteristics especially important for programming and problem solving. Further towards suitability for software development is their high level of interest and specialization, consistent with eagerness to learn and ability to make judgment and decisions. Theoretically, one can argue that in light of the hyper-systemizing theory of autism, individuals on the spectrum possess many of the analytical skills required by software developers (programming, math, problem solving, trouble shooting, etc.), perhaps more so than the neuro-typical developer [2, 4].

In light of the hyper-systemizing theory however, individuals on the spectrum will be challenged in terms of some of their communication, management and relationship skills. Individuals on the autism spectrum show narrow interest in other people, have a high need for sameness, and exhibit repetitive behavior that can detract from building relationships and adapting to change [4]. These characteristics in particular can challenge their coordination, teamwork, communication, and leadership skills. Individuals on the spectrum can be most productive when requirements are stable, and work roles and structures are routine and specific [29, 19]. Appendix A provides further detail of the strengths and

limitations of the cognitive style of ASC posited by the hyper-systemizing theory in relation to software development.

4. The Way Forward

The purpose of this paper is to further develop our understanding of the cognitive style of high functioning autistic individuals and map this style to skills relevant for software developers. The unique cognitive style of developers with ASC is clear from our synthesis of the literature. Our analysis, however, suggests that in order to benefit from and enable the further development of the talents of individuals with ASC, firms must adapt to the strengths and accommodate the needs of these developers. There are very few studies focusing on work related topics for HFA [19]. Below is a summary of strategies we identified from the few studies exploring employment and postsecondary transitions.

4.1. Design roles and responsibilities around ASC strengths and interests

Our earlier analysis revealed that HFA cognitive style is characterized with a great ability to perceive and process information, pay attention to detail, and systemize. This might also manifest in deep knowledge and narrow interests. Austin and Sonne [2] argue that in order to capitalize on the unique cognitive abilities of ASC, it is important to design roles that may best be served by those skills. They further suggest that job design should be based on a comprehensive understanding of individual capabilities rather than designing roles independent of the abilities and interests of the developers. For this reason, it is also important that ASC developers are not limited to executing small scoped testing roles that only draw on one dimension of their strengths (attention to detail). Morris et al. [19] and Gobb and Shmulsky [11] suggest that matching project and role assignments with the individual's interests to be desirable as well. For most ASC developers, it is key to focus on technical strengths rather than relying solely on interpersonal strengths [19] and to facilitate the exercise and development of interpersonal skills.

4.2. Design tasks and communicate task level information explicitly

The hyper-systemizing theory of autism suggests that individuals on the spectrum think systematically. Thus they seek and analyze information in order to recognize and fit information into particular structures. For this reason, it is important that the tasks associated with their roles be structured well and communicated clearly [11,19]. One can argue that individuals with ASC seek structure and thus may be best suited to work under development methodologies that promote stability and regularity than more dynamic and adaptable methodologies. Communication (preferably in writing) and specific articulation of the goals and direction of a project and associated tasks will be key to accommodate and enable ASC developers to contribute and add value in such dynamic environments. Austin and Sonne [2] suggest focusing on short term tasks with individuals with ASC to create clarity of expectation, while communicating when and how tasks will change over time.

4.3. Design an accommodating work environment

Sensory hyper-sensitivity creates challenges for individuals with ASC in the workplace. These challenges may be in the form of excessive attention to detail, socializing for long periods, multi-tasking, and over-stimuli [11, 19]. We suggest that the design of the physical work space for inclusive teams pay particular attention to sensory stimuli, such as noise and the quality of light. Accommodations for ASC developers to have the choice to work in private and telecommute become very important [19]. In the context of meetings and task related interactions, especially group meetings or meetings with managers, ASC individuals may not be able to multi-task between taking notes and contributing to conversations. Two strategies to address multitasking challenges are to audio recording meetings or to assign a person to take detailed notes for minutes, which can be distributed to the whole team so as to not single out a particular employee. Morris et al. [19] identified that developers prefer written communication to oral communication when communicating task level detail. Feedback from ASC developers might also be more appropriate and accurate in a written asynchronous fashion to allow them the time needed to process information and make connections.

4.4. Develop and maintain productive and meaningful inclusive work environment

Baron-Cohen et al. [4] suggest that ASC individuals tend to have narrow interests, exhibit repetitive and routine behaviors, and resist change. Also, developers with autism find it difficult to interpret nuances in communication and work culture

[19]. These characteristics makes it challenging to develop relationships with managers and coworkers, leaving individuals feeling isolated. It is important to create stable managerial and team relationships [19]. Gobbo and Shmulsky [11] suggest that managers regularly conduct one-on-one non-judgmental discussions with ASC developers. Peer mentors can play an important role in establishing the tone and culture of understanding and inclusiveness. As well, stigma and ignorance are often associated with ASC, making the environment less welcoming to those with different cognitive and interpersonal characteristics. Training managers and peers on the nature of ASC characteristics is imperative. Training must be accompanied with performance rewards structured to create accountability for inappropriate behaviors towards those on the spectrum.

5. Conclusion

In recent years, the technology industry has directed more attention towards employing and onboarding individuals with autism [2, 19]. Many of the employment programs focused on the autism characteristics of attention to detail and repetitive behaviors, and therefore, connected these employees to a limited set of roles including testing, security monitoring and quality assurance (e.g. [2]). In our paper, we suggested expanding our understanding of ASC cognitive skills. We used the hyper-systemizing theory of the cognitive style of HFA to define the strengths of ASC that might be suitable for the technology industry. We also defined the range of skills for software developers to assess how ASC cognitive style may meet the needs for those core skills.

Our analysis of the literature and the skills needed for software developers determined that individuals on the autism spectrum possess important cognitive skills suitable for software development. Most notably, our analysis revealed that ASC leans towards a range of analytical skills (information processes and systemizing) especially suitable for software development. Our analysis also determined that the very same cognitive skills present individuals with ASC may create challenges in terms of managerial, interpersonal, and communication skills. We concluded that to meet the demand for software developers, it is important that firms design roles and work environments that capitalize on the strengths of individuals with ASC and accommodate their needs. There is very little research or knowledge from practice on how to best design roles and inclusive work environments to accommodate employees with ASC [19]. This conceptual paper provides an introduction to our theoretical understanding of the cognitive style of ASC and strives to inform research aiming at employment of people with ASC in the technology field.

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Appendix A. Hyper-systemizing Theory of ASC Cognitive Style [4]

Cognitive Style	Strength Implications	Weakness Implications	Relevance to Software Development	Strategies
Hyper-systemizing	Rule-based system: Input-operation-output [4] Adherence to rules and standards [11, 19]	Resistant to change [19, 29]	View of software as a system of interrelated parts [4] Strict adherence to coding style and guidelines [2]	Provide a structured layout for work [11] Assign responsibility for code review [2, 19]
	System view: associations of rules in the context of a system [4, 14]	Have a specific routine behavior and can become rigid [29]	Complete tasks assigned [19]	Assign as devil's advocate role and peer review of code
	Recognize repeating pattern [19]	Repetitive behavior [4, 27, 29]	Spot bugs [2]	Assign work items which involve recognizing patterns.
Hyper-attention to detail	Excellent attention to detail [11]	Challenge in time management [19] Can stifle innovation [18]	Review code Conduct walkthrough [2]	Provide a structured guidelines and schedule of the project plan with detailed description of work items.
	In depth knowledge/passionate interest [11]	Narrow interests ("See the parts not the whole" - [11]	Out of the box thinking [19]	Allow to work on strength [11, 19]
Sensory hyper-sensitivity	Sensory hypersensitivity: Perceive and Process a large quantity of information from multiple sensory modes [4]	Challenges in inter-personal communication (especially synchronous), results in anxiety [11, 27, 29]		Focus on Strengths [4, 11, 19] Create a platform to share the design and code feedback in asynchronous mode such as mail/online tools.
		Challenges listening and multi-tasking [19]		Assign other team members to take notes. Train managers to reiterate the meeting minutes and clarify items with adequate details [11, 19]

Appendix B. Software Developer Skills

	Skill	Skill Description
Analytical		
	Problem Solving [16]	Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions
	Mathematics [15, 20]	Using mathematics to solve problems
	Programming [15, 20]	Writing computer programs for various purposes
	Systems Analysis [15]	Determining how a system should work and how changes in conditions, operations, and the environment will affect outcomes.
	Systems Evaluation [15]	Identifying measures or indicators of system performance and the actions needed to improve or correct performance, relative to the goals of the system. See more occupations related to this skill.
	Critical Thinking [15]	Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems
	Troubleshooting/Debugging [5]	Determining causes of operating errors and deciding what to do about it.
Design skills		
	Technology Design, Modeling [20, 23]	Generating or adapting equipment and technology to serve user needs. Knowledge of design techniques, tools, and principle involved in production of precision technical plans, blueprints, drawings, and models.
	Creativity/Innovation [15]	Breaking out established patterns and look at things in new perspective
Communication		
	Reading Comprehension [20]	Understanding written sentences and paragraphs in work related documents
	Active Listening [20, 30]	Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times
	Writing [20, 30]	Communicating effectively in writing as appropriate for the needs of the audience
Relationship/Collaboration		
	Team work [15, 16]	Actively looking for ways to help people and providing training and mentoring
	Customer orientation [15, 16]	Focus on the changing wants and needs of customers. Both internal and external customers

Management		
	Monitoring [20]	Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action
	Coordination [21]	Adjusting actions in relation to others' actions, managing interaction with vendors
	Judgment and Decision Making [20, 23]	Considering the relative costs and benefits of potential actions to choose the most appropriate one. Instinctive judgement
	Time Management [20, 30]	Managing one's own time and the time of others. Analyze user needs and software requirements to determine feasibility of design within time and cost constraints. Meeting deadlines.
	Stress management [21]	Handling pressure during tight deadlines
	Change Management, Adoption of dynamic and evolving methodologies [15, 21]	Being in sync with the industry and technical changes which happens at massive speeds
	Self-Development [21]	Drive and motivation to keep their knowledge and education up to date and focus on self-development.
	Eagerness to learn, Adoption of dynamic and evolving methodologies [15, 16]	Interest to learn new technology or additional skills
	Commitment & Responsibility [15]	Taking ownership of products and being accountable and responsible
	Startup environment (identified from various job descriptions)	Previous experience working in a start-up environment is a big plus